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Transmit Consultancy Ltd.
Chief Executive

April 21, 2014

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Regarding: Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions; Docket No. 12-268 and Public Notice: Media Bureau Seeks Comment on Widelity Report and Catalog of Potential Expenses and Estimated Costs, March 2014, DA 14-389

Dear Ms Dortch,

Transmit Consultancy Ltd. herewith submits its comments in the captioned proceeding, relating specifically to comment on Widelity's report (Broadcaster transition study) and catalog of potential expenses and estimated costs.

We would welcome the opportunity to discuss our comments with the FCC, broadcasters and other interested parties.

Yours sincerely,



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**Before the
Federal Communications Commission
Washington, DC 20554**

In the Matter of)	
)	
Expanding the Economic and Innovation)	Docket No. 12-268
Opportunities of Spectrum Through)	
Incentive Auctions)	

To: The Commission

Comments of Transmit Consultancy Ltd.

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Summary

Transmit Consultancy's comments are based upon experience of managing two repacking exercises in the United Kingdom and involvement with other European spectrum changes. Transmit recognizes that not all UK and European experience may be directly transferable to the U.S. context but there are a number of areas where the parallels are strong enough to suggest that the approaches developed and lessons learned could be taken into consideration. These parallels are clearly evident from the Widelity Report. Transmit presents its comments and experience for consideration.

Transmit supports the underlying theme of the Widelity Report that success of the Transition process is highly dependent upon unprecedented levels of co-operation between broadcasters, manufacturers and regulator. In order to achieve this it is necessary to establishment a US-wide coordination body and, in order for that body to be properly effective, it should be established now. Any further significant delay in providing cohesive leadership for the project will result in failure to leverage the benefits of such coordination.

Transmit is well placed to provide further expert advice on how best to move forward with this proposition and can also assist with international resource procurement where that is identified as a probable requirement.

Transmit believes that the Widelity Report (Response to the Federal Communications Commission for the Broadcaster Transition Study Solicitation – FCC13 R0003) provides a comprehensive summary of the issues facing the regulator, broadcasters, equipment manufacturers and suppliers during the planned repack. These issues reflect those experienced in the UK and Europe as outlined in our earlier comment to public notice “Media Bureau Seeks Comment on Catalog of Eligible Expenses and Other Issues Related to the Reimbursement of Broadcaster Channel Reassignment Costs, September 23, 2013, DA 13-1954” which can be found at <http://apps.fcc.gov/ecfs/document/view?id=7520955701>.

The challenge now – with the issues surfaced – is to begin to figure out how best the complex multi-dimensional engineering problem that is the repack can be approached to ensure success.

The Widelity report stresses the need for US-wide industry co-ordination and collaboration in a number of key areas. In fact it highlights several critical areas that make industry co-ordination and collaboration an absolute necessity. Based on our experience, Transmit believes that centrally managed – but consensus based – coordination is essential in light of the complex goals, and applicable limitations, of the incentive auctions. Specifically, a single-purpose organization operating within a framework established by the regulator would facilitate consolidated, central management for repacking that is coordinated by the Industry itself. The benefits of Industry coordination in this type of framework include:

- Maximizing the benefit to the public by meeting the spectrum goals in a timely manner;
- Minimizing any disruptive impact on the TV-viewing public and harm to participating broadcasters;
- Reducing relocation costs through efficient management; and
- Avoiding waste, fraud, and abuse.

In addition, these factors will be critical in addressing many of the issues identified in the Widelity report. The public interest will best be served by enabling participating broadcasters to minimize the impacts of disruptive events on their businesses and to participate in the repacking process in a commercially sophisticated manner.

Our comments discuss the opportunities that central coordination can bring to the repack program; and the importance of a phased, coordinated, realistic, iterative and principles based approach to transition planning and implementation to ensure success. In addition, we comment on potential cost and time mitigation techniques, and the catalog of potential expenses and estimated costs. Previously¹ we proposed a number of additional cost and time mitigation techniques (each having been successfully used in the UK) and a number of additional expenses and costs not listed in the Widelity report, we restate them in this comment. Our comments end saying that the Repack – which could potentially be very damaging to the broadcast industry – must facilitate industry innovation and minimizes ongoing viewer impacts to create opportunities to promote a strong future for broadcast TV.

In the UK, the independent (broadcaster owned) organization Digital UK that was originally tasked with delivering and communicating the Digital TV Switchover Repack (and then the 800 MHz Repack) was deemed so valuable to the industry that it is now an on-going entity to support and promote the UK's Broadcast terrestrial TV service Freeview. The company provides operational support for the platform, including management of the Freeview electronic program guide, and leads on developing DTT strategy, working with its broadcast partners and industry. It also provides viewers with information and advice about terrestrial TV channels, services and reception. In addition, and critically, it has the mandate to promote and defend the belief that any changes to the allocation of spectrum must continue to allow for a strong, free-to-air terrestrial TV service with the same level of coverage and range of channels that viewers enjoy today, and to ensure that any future decisions do not weaken the UK's broadcast TV platform and result in minimum disruption and cost for both viewers and broadcasters.

Throughout this comment we are trying to provide some of the keys that will begin to unlock how the planning, design and implementation for a Repack can begin, and how it can be delivered successfully:

- It is imperative now to decide and agree at an industry level “what a successful repack looks like.” What is a successful experience and outcome to the viewer, the broadcaster, the Government and FCC, and the supply chain? Only by defining a successful Repack at this high

¹ <http://apps.fcc.gov/ecfs/document/view?id=7520955701>

macro-level – with agreement across the industry - can you begin to unlock how transition planning best be approached.

- It is critical for the success of the reengineering program that limitations are accepted and factored into the planning and implementation process (*i.e.*, bad weather, difficult geographical terrain, limited technical resources) building in upfront contingency. It is only by acknowledging that there is a resource problem; that many transmission sites can only be worked on for narrow periods of the year (for terrain and/or weather reasons); that working in areas that trigger environmental and/or historical or tribal consultations will cause delays; that negotiations with 3rd party site owners and multitenant towers will be difficult can a Repack be successful. In fact, only by accepting these limitations up front can you begin to understand how to approach the Repack and unlock the challenges it represents.
- We believe that a principles based approach – to both the engineering and cost reimbursement – is critical to success. In the simplest of terms by “principles-based approach” we mean that all that can be done is done to proactively agree across an industry how elements, issues and challenges of the Repack will be dealt with upfront – you are effectively designing the decision making process upfront. Of course, not everything can be foreseen but that makes it even more important to address upfront the known issues. By adopting a principles based approach, decisions are made proactively about how elements, issues and challenges are to be approached, and importantly the tools and options available are identified and agreed. This then, enables the industry to focus on the un-foreseen issues and challenges that will inevitably arise as the Repack program rolls.

We believe that beginning to plan the Repack transition, the planning and the implementation of the Repack – a complex, iterative and multi-dimensional engineering challenge – can be made simpler and opportunities leveraged with a central coordination organization in place. That is not to say that such an organization makes a Repack easy or that establishing such an entity is easy – it is not! Stakeholder-wide backing and consensus, commitment by all involved to close trust gaps, and the people involved will determine the success of the coordination body in delivering the Repack.

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To: The Commission

Comments of Transmit Consultancy Ltd.

Transmit Consultancy ("Transmit") submits its comments in the captioned proceeding, specifically relating to the Widelity's report (Broadcaster transition study) and catalog of potential expenses and estimated costs. Transmit's experience with repacking exercises in the UK and in other European countries can inform the approach in the upcoming repack to accommodate 700 MHz wireless broadband auction winners. We certainly believe the lessons Transmit learned in the European process should be considered as part of the debate about repacking rules in the U.S.

Transmit supports the underlying theme of the Widelity Report that success of the Transition process is highly dependent upon unprecedented levels of co-operation between broadcasters, manufacturers and regulator. In order to achieve this it is necessary to establishment a US-wide coordination body and, in order for that body to be properly effective, it should be established now. Any further significant delay in providing cohesive leadership for the project will result in failure to leverage the benefits of such coordination.

Transmit is well placed to provide further expert advice on how best to move forward with this proposition and can also assist with international resource procurement where that is identified as a probable requirement.

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In addition, these factors will be critical in addressing many of the issues identified in the Widelity report. The public interest will best be served by enabling participating broadcasters to minimize the impacts of disruptive events on their businesses and to participate in the repacking process in a commercially sophisticated manner.

Our comments discuss the opportunities that central coordination can bring to the repack program; and the importance of a phased, coordinated, realistic, iterative and principles based approach to transition planning and implementation to ensure success. In addition, we comment on potential cost and time mitigation techniques, and the catalog of potential expenses and estimated costs. Previously² we proposed a number of additional cost and time mitigation techniques (each having been successfully used in the UK) and a number of additional expenses and costs not listed in the Widelity report, we restate them in this comment. Our comments end saying that the Repack – which could potentially be very damaging to the broadcast industry – must facilitate industry innovation and minimizes ongoing viewer impacts to create opportunities to promote a strong future for broadcast TV.

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to ensure that any future decisions do not weaken the UK's broadcast TV platform and result in minimum disruption and cost for both viewers and broadcasters.

Throughout this comment we are trying to provide some of the keys that will begin to unlock how the planning, design and implementation for a Repack can begin, and how it can be delivered successfully:

- It is imperative now to decide and agree at an industry level “what a successful repack looks like.” What is a successful experience and outcome to the viewer, the broadcaster, the Government and FCC, and the supply chain? Only by defining a successful Repack at this high macro-level – with agreement across the industry - can you begin to unlock how transition planning best be approached.
- It is critical for the success of the reengineering program that limitations are accepted and factored into the planning and implementation process (*i.e.*, bad weather, difficult geographical terrain, limited technical resources) building in upfront contingency. It is only by acknowledging that there is a resource problem; that many transmission sites can only be worked on for narrow periods of the year (for terrain and/or weather reasons); that working in areas that trigger environmental and/or historical or tribal consultations will cause delays; that negotiations with 3rd party site owners and multitenant towers will be difficult can a Repack be successful. In fact, only by accepting these limitations up front can you begin to understand how to approach the Repack and unlock the challenges it represents.
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I. Transmit Consultancy

Transmit Consultancy ("Transmit") is a team of broadcast TV experts, including business and technical expertise, headquartered in London and San Francisco, California. Transmit specializes in spectrum repacking projects, and has consulted in broadcast repacking projects across Europe, including projects like the FCC's upcoming incentive auctions. Transmit consults on and delivers big transformational broadcast projects, our genesis is spectrum repacking.

Together – working with broadcasters, the Government, the regulator, network providers and other Stakeholders – our consultants coordinated the end to end broadcast re-engineering program for two spectrum repacks in the UK to industry and political acclaim, under budget and on-time: leading unprecedented industry collaboration. In addition, our consultants have experience of broadcast TV networks and repacking projects in Australia, Serbia and Ireland.

For both UK repack programs we worked using public money. The Government financed the 800MHz repack; it reimbursed broadcasters for costs incurred by them to complete the repack; the fund being administrated and managed by the regulator (Ofcom). The 1st (Digital TV switchover) repack was financed by a combination of commercial and public money – owing to the unique way that the BBC is funded.

Transmit is currently consulting with broadcasters on the 3rd European repack resulting from the pending clearance (from Broadcasting) of the 700MHz band (due to be confirmed at the World Radio Conference in 2015). Our lead technical consultant Mark Evans currently consults to UK wireless operators launching 4G services at 800MHz on broadcast and wireless interference issues and management.

Transmit consultants have launched end-to-end broadcast TV networks, pioneering digital terrestrial TV (DTT) and HD broadcasting globally. Our consultants have launched and operated broadcaster shared multiplexes; set-up and managed the technical operations of both TV stations and broadcast TV platforms. Together we are experts in one of the most complex broadcast TV networks in the world.

Transmit is pleased to bring its experience to inform the Commission's approach to the challenges and opportunities of the U.S. spectrum repack with an open and objective perspective.

II. Introduction

Transmit believes that the Widelity Report (Response to the Federal Communications Commission for the Broadcaster Transition Study Solicitation – FCC13 R0003) provides a comprehensive summary of the issues facing the regulator, broadcasters, equipment manufacturers and suppliers during the planned repack. These issues reflect those experienced in the UK and Europe as outlined in our earlier comment to public notice “Media Bureau Seeks Comment on Catalog of Eligible Expenses and Other Issues Related to the Reimbursement of Broadcaster Channel Reassignment Costs, September 23, 2013, DA 13-1954” which can be found at <http://apps.fcc.gov/ecfs/document/view?id=7520955701>.

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Our comments discuss the opportunities that central coordination can bring to the repack program; and the importance of a phased, coordinated, realistic, iterative and principles based approach to transition planning and implementation to ensure success. In addition, we comment on potential cost and time mitigation techniques, and the catalog of potential expenses and estimated costs. Previously³ we proposed a number of additional cost and time mitigation techniques (each having been successfully used in the UK) and a number of additional expenses and costs not listed in the Widelity report, we restate them in this comment. Our comments end saying that the Repack – which could potentially be very damaging to the broadcast industry –

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are identified and agreed. This then, enables the industry to focus on the un-foreseen issues and challenges that will inevitably arise as the Repack program rolls.

We believe that beginning to plan the Repack transition, the planning and the implementation of the Repack – a complex, iterative and multi-dimensional engineering challenge – can be made simpler and opportunities leveraged with a central coordination organization in place. That is not to say that such an organization makes a Repack easy or that establishing such an entity is easy – it is not! Stakeholder-wide backing and consensus, commitment by all involved to close trust gaps and the people involved will determine the success of the coordination body in delivering the Repack.

III. Defining a successful Repack

In our previous comment⁴ we proposed seven Repack challenges and opportunities presented to broadcasters and other stakeholders. We stated that these opportunities and challenges must be at the forefront when the Commission considers how the repack transition and cost reimbursement are both “reasonably” approached. They also, however, provide a starting point to begin to answer the question “what does a successful repack look like?”

The opportunities and challenges include:

1. To release spectrum to the successful bidders/mobile carriers in a transparent and planned manner that minimizes the time it takes the new service licensees to launch new services to market, and the Government to collect auction revenues.
2. To provide an environment in which participating broadcasters have confidence to work together to plan and implement the repack and to explore opportunities for sharing spectrum, creating a positive precedent for future spectrum efficiency.
3. To communicate effectively with American viewers so that they will understand the benefits of repacking and the steps must take to continue viewing their favorite programming.
4. To enable participating broadcasters to efficiently plan and reengineer their networks in a robust and “like for like” manner with comparable coverage.
5. To minimize costly transition time while ensuring that participating broadcasters can remain on-air when complex national and international spectrum-use inter-dependencies are at play.
6. To ensure that the engineering and equipment supply-chain (with scarce resources) can successfully meet the needs of and deliver the repack nationally within the three-year transition period.
7. To ensure that the \$1.75 billion TV Broadcaster Relocation Fund to reimburse participating broadcasters for “reasonable costs” is sufficient, and that it is subject to appropriate accounting safeguards.

We propose that only by determining the critical successful factors for each of these opportunities and challenges of the Repack program – essential the core elements of the Repack program – can you understand what a successful Repack is? Only by defining a successful Repack at this high macro-level – with agreement across the industry - can you begin to unlock how transition planning best be approached.

⁴ <http://apps.fcc.gov/ecfs/document/view?id=7520955701>

IV. Central coordination for a successful Repack

The Widelity report stresses the need for US-wide industry co-ordination and collaboration in a number of key areas. In fact it highlights several critical areas that make industry co-ordination and collaboration an absolute necessity, for example:

- The extreme scarcity of resources across many different skill sets and suppliers;
- The need for a “transition plan”;
- The manufacturers’ comment that “... it is imperative that the industry coordinate the ordering process so that they can manage staffing, spin up production lines, preorder raw materials and parts, and effectively utilize production resources (Widelity report p38); and
- To avoid the creation of demand based pricing across most if not all external engineering resource and suppliers.

The Widelity report and its call for industry wide coordination mirrors the comments made by Transmit in our previous comment⁵ supporting our view that a central co-ordination body is required and should be established as soon as possible in order to maximize the benefits of a collaborative approach and to minimize the risks associated with fragmentation of the project.

Transmit believes that centrally managed – but consensus based – coordination is essential in light of the complex goals, and applicable limitations, of the incentive auction and repack. Specifically, a single-purpose organization operating within a framework established by the regulator would facilitate consolidated, central management for repacking that is coordinated by the Industry itself. The benefits of Industry coordination in this type of framework include:

- Maximizing the benefit to the public by meeting the spectrum goals in a timely manner;
- Minimizing any disruptive impact on the TV-viewing public and harm to participating broadcasters;
- Reducing relocation costs through efficient management; and
- Avoiding waste, fraud, and abuse.

The public interest will best be served by enabling participating broadcasters to minimize the impacts of this potentially disruptive event on their businesses and to participate in the repacking process in a commercially sophisticated manner.

Section 26 of the Widelity report (Potential Cost and Time Mitigation Techniques) identifies the following areas where a coordinated approach is deemed necessary or at least highly recommended:

- The coordination of orders with manufacturers and creation of “Master Service Agreements;”
- The coordination of crew deployments;
- The establishment (and presumably administration of) an inventory of tower crews at both a regional, US-wide and – even - international level;

⁵ <http://apps.fcc.gov/ecfs/document/view?id=7520955701>

- The co-ordination of existing Industry resources;
- The co-ordination of Cutover dates; and
- The creation of an equipment exchange.

In addition, Transmit believes that there would be benefit in the co-ordination of coverage verification, and of other limited resources such as RF Engineers and Structural Engineers.

To maximize the economies of scale and the efficiencies available from industry co-ordination it makes sense to establish a single Industry wide organization to oversee and manage the transition to the benefit of broadcasters, the FCC and, as importantly, the viewers. Transmit would suggest that such organization could also provide support for Non-Commercial Stations (see Section 24 of the Widelity Report) and provide the timely information flow identified as a requirement of MVPDs (see Section 25).

While it is undoubtedly true that “broadcasters are very experienced at channel moves and technology transitions” there is no apparent history of the level of industry co-operation and co-ordination required to successfully achieve this re-pack transition without undue disruption to services and to viewers. This is because there has never previously been an attempt made to implement changes of such a widespread and interdependent nature, and as you repack broadcast into less spectrum the challenges become more complex.

Transmit’s experience in the UK of the need to establish an unparalleled level of co-operation between rival broadcasters in order to manage re-packing exercises suggests that there would be a real value to the establishment of an umbrella organization in the USA with a singular purpose of ensuring delivery of the project in an efficient, timely, cost effective and minimally disruptive manner. We note that the Widelity Report suggests the establishment of a “Reimbursement Contractor”. It may be that the two functions of project co-ordination and re-imbursement could be combined but in any event the two organizations should be charged with working closely together to achieve the aims elucidated above.

Industry collaboration and coordination, however, must be built on a consensus basis. Broadcaster collaboration and coordination can be valuable in developing innovative ways to save program costs, optimize the use of scarce resources and deliver pragmatic solutions. A mechanism designed to facilitate, at an industry level, broadcaster collaboration and coordination to deliver a repack can greatly increase the chances of program success but ideally it should emerge from the broadcaster players themselves. While such a mechanism for fostering industry collaboration and coordination requires unequivocal Government and regulator support and industry engagement can be formalized in licenses, the guidance for the structure of such a mechanism cannot be too prescriptive. For example, one such mechanism might be the establishment of a single-purpose delivery organization with just the “framework” set by Government and/or the regulator. For an industry to begin to collaborate and coordinate itself, it must be enabled to design itself how it does this. It is critical that the broadcast industry be given every opportunity to minimize the impacts of what is essentially a disruptive event on their businesses and that participating broadcasters are enabled to approach delivering a project with a public purpose in a business minded and commercially astute manner.

The best structure and mandate for such an organization(s) can only be established once the question “what is a successful repack?” has been defined and bought into across the industry. It is from this set of “critical success factors” that a framework for a “consensus based “single-purpose coordination organization can be designed by the regulator. The role of this organization being essentially to facilitate, consolidate and centrally manage the repack transition for and with the industry - by the industry itself.

Industry co-ordination is required from pre-planning to implementation to ensure the efficient and timely deployment of limited resources across a US wide project; a project which must address and carefully balance the overall objectives of the repack with the priorities of individual stations.

V. A phased and coordinated transition plan for a successful Repack

The Widelity report calls for an industry wide transition plan to deliver the Repack, by default any industry-wide plan will have to be coordinated and will need to be phased – again this mirrors the comments made by Transmit in our previous comment⁶.

A phased and coordinated spectrum planning and broadcast reengineering approach can greatly facilitate broadcast transmission continuity and protect station coverage through the transition. A phased and coordinated planning approach increases confidence in the relocation process, projected costs, and the program, generally. The complexity and limitations of the repack also means that a phased approach might be the only way to the three year transition period, given that spectrum and resources are scarce, and spectrum interdependencies complex. Planning enables engineering and spectrum management based tools to be used to ensure seamless on-air transition with consistent coverage during the transition. Planning also minimizes the time participating broadcasters spend in expensive transitional states, and allows participating broadcasters to proactively manage and mitigate any impacts to a station’s post-transition coverage. Central planning significantly decreases resources, cost and elapsed time required across the whole project.

A phased broadcast reengineering approach can expedite the launch of new mobile services in critical markets. A phased and US-wide planned approach can effectively enable the TV industry, some broadcasters and some difficult areas (*e.g.*, areas along the borders of Canada and Mexico) more time while repacking in priority areas is expedited. In the U.S. 800 MHz reband, the Commission ordered the reband to proceed in multiple geographical areas in parallel when international relations, engineering and interference inter-dependencies allowed. Central management of a phased approach will enable a smooth transition, as it enables the extreme

⁶ <http://apps.fcc.gov/ecfs/document/view?id=7520955701>

limitations of this project to be managed and/or mitigated i.e. shortage of resources, weather and terrain issues.

This approach also sets the project up to be a better experience for the TV viewer. Only with this approach can the number of cutovers a viewer experiences be minimized, only with this approach could you hope to aim for just 1 or 2 needs for each viewer to rescan their set top box or TV. In addition, A clear, attainable, and secure public timetable is critical so that the viewing public can have confidence in what they need to do and when. A centrally managed, large-scale phased program with multiple dependencies should only announce dates to the public when work is sufficiently far advanced to give confidence that those dates can be met. An emerging date announcement process can also be used to alert the viewing public to the date and time on which their viewing habits may be impacted. In addition, the management of technical and communications plans in parallel can greatly facilitate the accurate and timely communication of technical changes and can even be used to drive spectrum planners and engineers to minimize viewer impacts in their planning.

VI. A realistic and iterative approach to engineering planning for a successful Repack

One area the Widelity report fails to acknowledge is the iterative nature of a Repack program. Repacks are for an engineering perspective iterative in their planning, design and implementation. Reengineering broadcast TV networks is a multi-dimensional puzzle with complex interdependencies. Technical decisions made by one participating broadcaster can impact multiple other decision points and broadcasters. As a result unified high-level, overarching spectrum and engineering design/planning needs to be iterative with continuous feedback loops to ensure the most robust broadcast solutions are reached and the rollout timetable is optimized. Structures and processes will need to be able to handle this iterative nature and feedback loops both within individual broadcast companies and between broadcast companies – and of course the FCC itself. This will be the norm not the exception. A central coordination body can facilitate, manage and mitigate iterations and feedback between parties. Without a central coordination body, the risk is high that the Repack programme will falter, even fail.

Whilst the Widelity report acknowledges many issues and problems the Repack will encounter it does not go as far as to state that these issues must be faced head on from the start – the report does not address the question of timing. It is critical for the success of the reengineering program that limitations are accepted and factored into the planning and implementation process (*i.e.*, bad weather, difficult geographical terrain, limited technical resources) building in upfront contingency. It is only by acknowledging that there is a resource problem; that many transmission sites can only be worked on for narrow periods of the year (for terrain and/or weather reasons); that working in areas that trigger environmental and/or historical or tribal

consultations will cause delays; that negotiations with 3rd party site owners and multitenant towers will be difficult can a Repack be successful. In fact, only by accepting these limitations upfront can you begin to understand how to approach the Repack and unlock the challenges it represents.

To take multitenant towers as an example, proactive and early engagement with the radio and mobile industry is essential. It cannot be assumed a mobile operator will cooperate throughout the repack reengineering simply because it is a successful bidder who will gain spectrum from the repack. Nor can it be assumed that a radio station, even if owned by the same broadcast corporation as the TV station on the tower, will cooperate. In the UK for both repacks we engaged early and consistently with both the radio and mobile industries agreeing principles for impacts to their services as a result of reengineering works. Importantly, this approach also ensured that requests for compensation for interruptions to service and/or coverage impacts during the repack reengineering gained no traction, having been managed by agreeing upfront principles between the affected parties and the central coordination body.

The restrictions and limitations the Repack faced must be understood in the planning stage, solutions must be proactively found upfront, and if no solution can readily be found then potential mitigation techniques and options understood and agreed across the industry with the FCC at the very beginning of the project.

VII. A principles based approach for a successful Repack

Throughout this comment we are trying to provide some of the keys that will begin to unlock how the planning, design and implementation for a Repack can begin, and how it can be delivered successfully. We believe that a principles based approach – to both the engineering and cost reimbursement – is critical to success. In the simplest of terms by “principles-based approach” we mean that all that can be done is done to proactively agree across an industry how elements, issues and challenges of the Repack will be dealt with upfront – you are effectively designing the decision making process upfront. Of course, not everything can be foreseen but that makes it even more important to address upfront the known issues. By adopting a principles based approach, decisions are made proactively about how elements, issues and challenges are to be approached, and importantly the tools and options available are identified and agreed. This then, enables the industry to focus on the un-foreseen issues and challenges that will inevitably arise as the Repack program rolls.

Predetermined engineering principles foster clear collaboration, save costs and expedite repack implementation. A principles-based approach can be used to attain industry clarity and consensus on key technical matters, making clear options available to participating broadcasters and providing transparency to the decision-making processes when the repack is under way. It is critical that participating broadcasters are involved in and engaged with the design of the

governing principles. Such an approach can greatly ease the management of the TV Broadcaster Relocation Fund and expedite the repack implementation because the volume of technical principles open to debate is contained and participating broadcasters can work to a set of network re-planning principles and tools to gain confidence that the costs associated with their approach will be reimbursed. For example, principles might cover how spectrum is allocated to participating broadcasters in markets, the criteria for replacing and/or modifying antennas, processes for exchanging spectrum between stations, engineering techniques (that are reimbursable) for regaining coverage lost as a result of the repack.

Examples of engineering areas where principles can be agreed upfront:

- Criteria for minimizing the disruptive harm to broadcasters e.g. there will be no material adverse consequence to existing broadcast infrastructure; broadcasters shall bear no cost (reasonably incurred) to accomplish the relocation;
- Criteria for minimizing any disruptive impact on the TV viewing public e.g. how and when switching breaks, outages and events requiring the viewer to rescan are handled and communicated;
- How channels are allocated to participating broadcasters, and how exceptions are handled when complex spectrum interactions require allocations to be revisited;
- The definition of TV coverage areas and how each is protected for different reception devices i.e. roof-top aerials, set-up aerials and nomadic devices;
- The criteria for replacing and/or modifying antennas;
- How international requirements are handled;
- The criteria for replacing or retuning transmitters;
- The process for exchanging spectrum between stations;
- Band-edge handling to guard against interference with mobile use;
- The policy for transitional broadcast states which impact adjacent stations;
- How spectrum being released to successful bidders/mobile carriers might be temporarily used to ease and advance the repack program;
- Engineering techniques for regaining coverage lost as a result of the repack; and
- The requirements for technical documentation (in this case principles may become templates).

In addition, clear principles for cost reimbursement are critical to the success of the repack. Setting clear principles for cost reimbursement in advance of the start of the project is critical since otherwise participating broadcasters are unlikely to commit to the plan. Ideally, these should be based on best practice engineering and project management principles with each participating broadcaster being awarded a budget for its part in the program and robust reconciliation and accountability to ensure proper control of expenditure of public funds.

A fund to reimburse participating broadcasters using public money needs to be fit for purpose, balancing effective governance with fair distribution. In our experience it is critical that budgets be allocated to each participating broadcaster in advance with reconciliation against actual costs at the end of the project. The alternative where monies are applied for on a granular cost-by-cost basis is far more expensive to administer and wasteful.

The following factors are critical for successful fund administration and must be approached transparently, proactively and with consensus by “principles”:

- Industry consensus and clear guidance on how funds are allocated to participating broadcasters in advance;
- A mechanism for public and less affluent commercial participating broadcasters to receive funds upfront to finance the relocation to avoid delays associated with scarcity of funds;
- A provision for planning funding to allow each participating broadcaster to consult with design and construction engineers to plan for the relocation and avoid costly and delaying surprises;
- A provision for "upgrades" during the relocation process, so that participating broadcasters need not expend energy on antiquated facilities, but may apply the TV Broadcaster Relocation funds to innovative facilities while relocating;
- Policy, accounting & legal requirements for fund administration that do not incur unnecessary and counter-productive costs, or cause delays;
- The “reasonable” treatment of participating broadcasters with parity across all types of broadcasters;
- Simple, pragmatic and appropriate process and procedures based on best practice engineering and project management principles;
- Direct and transparent relationships between the fund administrator and participating broadcasters;
- Pragmatic issue resolution that avoids delay, including use of mediators, as in the U.S. 800 MHz reband;
- The acceptance of trade-offs between cost and the speed of delivery;
- Clarity and agreement on how budgets are drawn-down and cash is handled;
- Transparent and consistent reporting of decision-making to the industry;
- The ability for participating broadcasters to manage change within their budget; and
- Up-front communication of true up and audit requirements and processes.

A coordination organization can play a key, proactive and leading role in setting up and agreeing with the industry such principles; they can then implement and adapt them – with the industry – as the repack program emerges and rolls. Such principles can be considered a great vehicle for creating transparency, certainty and trust across the program and industry – in essence, they make it easier for all to work together.

VIII. Further comment on coordination requirements and opportunities

The Widelity Report identifies a number of specific issues which resonate with Transmit's experience in other markets. Based on that experience we offer the following comments.

- **Towers (new and strengthening):** A key factor in determining the shape, phasing and elapsed time of the transition plan is the number of new towers and the number of towers that require strengthening. The lead times for these builds will determine the program's critical path (s) both regionally and US-wide. We advise that the requirement for new towers and tower strengthening is understood as soon as possible, and accepted as a key factor to determining an efficient transition plan.
- **Towers (temporary):** Temporary towers may be required in some locations in order to provide service continuity. A coordinated plan would be able to assess whether these are suitable for deployment in multiple locations over the duration of the project, therefore, minimizing costs of this element. Again, we advise that the requirement for temporary towers is understood as soon as possible and the propensity to share temporary structures by reusing them be proactively worked through early on. Again, this can be a key factor to determining an efficient transition plan.
- **Tower Crews:** Given the limited number of available crews capable of operating on complex towers it makes sense to establish the feasibility of recruiting additional resource from the international marketplace.
- **Helicopter Lifts:** The Widelity Report identifies the limited availability of suitable helicopters and the competing demands for their services across other activities. It is critical, therefore, that the helicopter lift program is coordinated and optimized across the national program.
- **RF Engineers:** RF planning and consequential activities need to be coordinated and prioritized on a US-wide basis. The interdependencies of this complex exercise mean that unless all stations in a market move at the same or very similar speed none may be able to complete until the slowest is ready. For that reason it is important to co-ordinate and prioritize deployment of RF engineering resource from the beginning of the pre-planning phase. It is of limited benefit if some stations proceed quickly if they are later to be held back by those less able to mobilize.
- **Structural Engineers:** Again we note that "proper planning and sequencing of the post-repacking transition process will be of paramount importance".

- **Transmitters and Transmitter Retuning:** As noted in the Widelity Report, “manufacturer support is critical” in relation to supply of replacement transmitters. In order to minimize the likelihood of supply problems “...the process of ordering equipment (must be) orderly and broadcast stations (should) order equipment as early as possible”. This can only sensibly be achieved if it is coordinated on a national basis. The sequence of ordering and delivery of transmitters must follow the phased transition plan otherwise unnecessary bottlenecks will be encountered. Manufacturers can (and in some cases must) be used as a resource for transmitter retuning but even with their involvement careful co-ordination across the whole project is required to optimize the deployment of what will still be a limited supply of suitable engineers.
- **Transmission Lines:** Transmit notes that “manufacturers recommend that orders be consolidated or otherwise coordinated to avoid piecemeal jobs and to allow uniform production”. Again this points to the need for an overarching co-ordination organization.
- **Antennas:** Ideally, the Channel Plan should be informed by the capability of the existing antenna population to handle different frequencies so that, where a frequency allocation choice is available, the impact on the infrastructure can be factored in thereby minimizing cost and disruption. The Widelity Report suggests that the risk of a supply bottleneck for antenna supply is low but antenna manufacture is a process with relatively long lead times. It can also be an iterative process where range testing results often require products to go back into the production line. In these circumstances it will be important for a central coordinating organization to be in a position to call the priorities since rectification of one antenna can result in delays for products further down the production line. We note that in any event manufacturers have identified a “...need to ‘smooth out’ the ordering process...” and “If the orders are bunched where everyone is trying to acquire the same equipment at the same time, there will be delays and difficulty scheduling the work.” These requirements are familiar to Transmit from our UK and European experience and we would commend the use of an online database to co-ordinate the antenna design, procurement, and delivery and installation process.
- **Coverage Verification:** Again a limited available resource means that national level coordination makes sense. Where field measurements are required, the process could be expedited by coordinated use of helicopter measurement of ERPs.
- **Noncommercial Stations:** The Widelity Report highlights the particular issues that may be faced by Noncommercial stations. Many of these issues could be overcome by providing support from the central co-ordination body.
- **MVPDs:** The requirement of the MVPDs for detailed information about frequency changes between 6 months and 1 year ahead of the need for action reflects a need that will exist

across all the stakeholders in the transition process which can best be met by a coordination body – to the benefit of all.

- **Case Studies:** The Case Studies included with the Widelity Report are useful templates for the exercise that will need to be undertaken for each tower and each antenna. However, Transmit’s experience suggests that they can be nothing other than a broad template because each installation is different in some way and each transition will throw up its own challenges. We would propose that the next step is to model the costs of the program US-wide.

IX. Potential cost and time mitigation techniques

Transmit agrees that all listed (p.38 & 39) cost and time mitigation techniques are potential options, and we would advise that they are all worked through - as soon as possible - to firstly understand more their feasibility and secondly to establish how they might be implemented.

The Widelity report does propose, “Station groups should consider entering into Master Service Agreements (MSA).” In our experience creating such framework agreements is the most important – cost and time - mitigation technique available. In the UK for the Digital TV Switchover repack, framework agreements were negotiated for all transmission sites with the main suppliers of transmitters, combiners and antennas based on aggregated predicted demand. This then allowed individual companies to draw down individual items at the discounted and locked in price. This approach enabled manufacturers to understand and manage demand. It also enabled broadcasters to benefit from product developments during the time of the repack; if the manufacturers increased a product’s specification but it remained the only piece of kit to meet a particular requirement the price was held.

In our previous comment⁷ we proposed a number of additional cost and time mitigation techniques, each having been successfully used in the UK, we restate them here:

- **Reassigning channels using a 2-step frequency plan reduces banding issues and, therefore, costs.** Proactively and consistently minimizing the number of channels each station is shifted in the repack band plan will reduce costs significantly. In the UK for the 800MHz repack, all stations on channels 61 and 62 were shifted to 48 to 53, and some stations using channels 48 to 53 were shifted to 39 to 40. The benefits of a two-step repack are the less channels a station moves the more likely its antenna can be modified and still meet coverage objectives; the more likely and less expensive it is to retune the transmitter. In addition, domestic aerial groups were respected eradicating the need for any consumer to change their rooftop aerial. A two-step repack does require central coordination of planning

⁷ <http://apps.fcc.gov/ecfs/document/view?id=7520955701>

and implementation. The lower spectrum shifts must happen first so that the upper shift is possible – this is simply not possible unless participating broadcasters are working together in a collaborative and coordinated - centrally managed - way.

- **Using and sharing transportable transmitters can reduce costs and waste while keeping participating broadcasters on-air during the repack.** A transportable transmitter is a transmitter (or set of transmitters) in a container that can be moved around the country. Transportable transmitters can be used to take the existing permanent transmitter(s) out of circuit; existing broadcasts use the containerized transmitters which are outside (often in the car park) whilst the existing transmitters - inside - are replaced or retuned ready for the repack. Using containerized transmitters keeps participating broadcasters on-air during the repack engineering whilst also eliminating the need for building works to accommodate transitional transmitters. In the UK for the 800Mhz repack these transportable transmitters were re-used and shared between broadcasters. To enable these cost savings to be made the implementation plan must be centrally coordinated and phased. Sharing transmitters to enable the re-use of transitional equipment does require collaboration and coordination between broadcasters. Transportable transmitters could be shared nationally, regionally and/or within broadcast corporations. The greater the coordination and sharing of transitional equipment the greater the savings and the lower the waste.
- **Using extra port combiners can reduce costs and waste whilst keeping participating broadcasters on-air during the repack.** Adding ports to combiners removes the need for combiner replacement but allows preparatory infrastructure work to begin earlier and preserves continuity of service during the repack as the existing permanent combiner does not need to be retuned or replaced.
- **Incentivizing cost savings:** In other countries the monies saved through cost saving activities have been shared with broadcasters through gain share mechanisms.
- **Economies of scale within participating broadcasters** Incentivizing participating broadcasters to co-ordinate repacking across many stations could introduce further cost savings; this would enable expertise and experience to be shared and economies of scale accessed. One size will not fit all. The geographical distribution of stations and/or the corporate governance structure within a company will determine how best to share resources across stations to decrease costs.

X. Catalog of potential expenses and estimated costs

It is difficult to comment on the potential expenses and estimated costs owing to the lack of definitions and/or without clarity on the scope of technical work under consideration (for example, when resources are estimated). In addition, we would refer back to our earlier comment that repack planning is an iterative process – something missed in the Widelity report – and that this iterative nature (the need to revisit and refine elements as a result of factors from other stations and broadcast corporations) will impact resource usage and cost.

In our previous comment⁸ we proposed a number of additional expenses and costs not listed in the Widelity report, we restate them here:

- **On-going incremental operational costs:** Broadcasters should be reimbursed for any ongoing incremental operational costs as a result of repack infrastructure changes; this category should be added to the catalog. One example of incremental operational costs is the additional electricity costs associated with moving to a higher-powered transmitter. In order to avoid a never-ending compensation program, the principles for applying a lump sum payment for ongoing incremental operational costs should be agreed in advance.
- **Mitigating and managing interference from other stations:** Interference from a TV station to another TV station as a result of the repack will need to be managed and mitigated. Interference mitigation should be a separate cost category. Mitigating interference from other stations will generate additional engineering costs - for example, powers might need to be changed, filters added or antennas might require modification. Costs to manage interference between TV stations can be decreased by agreeing up front the principles by which engineering techniques can and should be used. In addition, early recognition and mitigation of coverage issues caused by the repack will create a more robust solution and in the long term be cheaper. Designing antenna and transmission systems to mitigate interference requires an iterative and coordinated planning approach because by definition it is all about interdependencies.
- **Internal resources:** The catalog makes no provision for the use of internal resources. In the U.S. 800 MHz reband, internal resources were reimbursed at demonstrated cost plus a benefit load. In this repack, where internal resources are deployed in furtherance of the repack, participating broadcasters should receive reimbursement for those costs. The alternative is that participating broadcasters will be incentivized to use potentially more expensive external resource.
- **Attorneys, accountants and management resource:** In the U.S. 800 MHz reband, the cost of outside attorneys was reimbursed for any task reasonably necessary to the reband. Negotiations, both of the overall cost of the reband and the agreements with the vendors, tower owners and engineers participating in the reband, strategic counseling, and application preparation, were all reimbursable. Participating broadcasters should be supported as well

⁸ <http://apps.fcc.gov/ecfs/document/view?id=7520955701>

as the 800 MHz licensees subjected to rebanding in the U.S. In addition to attorneys, participating broadcasters should be able to call upon any reasonably necessary professional advice to manage the repacking process. Adequate guidance from able advocates will ensure proper planning and effective execution of the repacking process. In addition, general business resources -- attorneys, accountants -- will be required to manage a broadcast company's relationship with the fund administrator -- protecting the company's interests and ensuring compliance with reimbursement policy and procedures. It is critical that the reimbursement policies and procedures of fund administration themselves do not diminish the participating broadcaster's confidence in the process, slowing repacking and creating unnecessary and disproportionate delays in the ultimate realignment of the spectrum.

XI. Information management

A repack program requires the management of vast amounts of information both commercial and technical -- all of it extremely detailed. This is another area we propose requires early consideration to ensure success. In addition, to volume the format of data should also be considered. In our experience, the standardization of information across broadcast companies is critical to the success of the planning and implementation process but also to setting up the reimbursement to succeed. For example, "as built documentation" for existing sites can be problematic as the quality -- for many reasons -- can vary dramatically. Consider how the reimbursement process can work if the baseline documentation for existing sites varies both dramatically in quality and format.

In our experience, a bespoke point of authority online resource for managing the repack engineering program is critical to ease the design, planning and implementation of a high-scale and extremely challenging project. To centrally manage an engineering repack program of this scale across multiple participating broadcasters requires the smart use of technology to facilitate a transparent and shared understanding of what is going on. A secure online resource (with the required access and user controls) can be used to manage, for example, the status of spectrum allocations and use, iterations of band-plans and repack roll-out plans, engineering workflow and interdependencies between broadcasters, cost reimbursement applications and sign-offs. Critically, as a point of authority program resource multiple stakeholders can remain across the project as they require to different degrees of detail, dramatically decreasing the project management drain and cost across all stakeholders.

XII. Promoting a strong future for broadcast terrestrial TV

A repack program that facilitates industry innovation and minimizes ongoing viewer impacts would create opportunities to promote a strong future for broadcast TV. The repack program presents an opportunity for broadcasters to consider the adoption of innovations in the way that they use spectrum. Such innovations can promote spectrum efficiency while at the same time creating opportunities for broadcasters to launch new services thereby underpinning the future of the terrestrial television platform. Reimbursement policies should be sufficiently flexible to sort out reimbursable costs and allow a participating broadcaster to apply the reimbursements to upgraded facilities.

To provide an environment in which broadcasters have confidence to work together to implement the repack and explore the opportunities for sharing towers, antennas – even multiplexes and spectrum – it is critical to guarantee and promote a strong future for broadcast terrestrial TV.

The global trend is to squeeze broadcast use of spectrum and exert pressure for greater spectrum efficiency across all users. These factors are inevitable and it is time to consider how broadcasters can share towers, antennas multiplexes and spectrum – to be fit to ensure the on-going use of spectrum for broadcasting. Worldwide experience shows that broadcasters can successfully share these resources and confidence should be gained from understanding the models that exist. However, it must be appreciated that this begins to open some big strategic questions for the broadcast industry.

The answers to these questions may become clearer as this proceeding progresses. It is clear, however, that the repacking process must be centrally managed to be fair and effective. Costs reasonably related to repacking must be reimbursed, and the process must be managed to minimize the impact on the viewing public.

Project management of a program of the size of the broadcast station repack benefit from central management aligning all involved organizations. A central framework can deliver a consensus driven, simple, fair design, flexible enough to enable a broadcaster to adapt without disruption to its business.

Transmit urges the Commission to adopt a structure for repacking that is coordinated by a central manager, ensuring uniform processes and parity among broadcasters.

In the UK, the independent (broadcaster owned) organization Digital UK that was originally tasked with delivering and communicating the Digital TV Switchover Repack (and then the 800 MHz Repack) was deemed so valuable to the industry that it is now an on-going entity to support and promote the UK's Broadcast terrestrial TV service Freeview. The company provides operational support for the platform, including management of the Freeview electronic program guide, and leads on developing DTT strategy, working with its broadcast partners and industry. It also provides viewers with information and advice about terrestrial TV channels, services and reception. In addition, and critically, it has the mandate to promote and defend the belief that any

changes to the allocation of spectrum must continue to allow for a strong, free-to-air terrestrial TV service with the same level of coverage and range of channels that viewers enjoy today, and to ensure that any future decisions do not weaken the UK's broadcast TV platform and result in minimum disruption and cost for both viewers and broadcasters.

XIII. Conclusion

Transmit supports the underlying theme of the Widelity Report that success of the Transition process is highly dependent upon unprecedented levels of co-operation between broadcasters, manufacturers and regulator. In order to achieve this it is necessary to establishment a US-wide coordination body and, in order for that body to be properly effective, it should be established now. Any further significant delay in providing cohesive leadership for the project will result in failure to leverage the benefits of such coordination.

Transmit is well placed to provide further expert advice on how best to move forward with this proposition and can also assist with international resource procurement where that is identified as a probable requirement

Respectfully submitted,

TRANSMIT CONSULTANCY LTD.

A handwritten signature in blue ink, consisting of a large, stylized 'M' followed by a horizontal line and a small flourish.

April 21, 2014

Appendix 1: Transmit management team

Jules Howard-Wright, Principal Consultant & Co-Founder

From 2006 to 2012 Jules was Broadcast Project Director at Digital UK for the Digital TV Switchover and 800MHz repacking programs. As Broadcast Project Director, she managed the technical planning, co-ordination and stakeholder management for the re-engineering of the entire UK television transmission network. During 2011 and 2012, Jules also led the technical operations and development of the UK's terrestrial platform Freeview on behalf of multiplex operators.

Jules has worked in broadcasting at an industry level for close to 15 years and has delivered technical projects (TV, internet and mobile) her whole career. Her career started at a digital communications agency (now Digitas LBi), after which Jules spent a year with a New York dot.com. As a Commercial Manager at a broadcast production house, she managed licenses delivering satellite and cable projects in the UK, U.S., Israel and Australia. In 2004, Jules started her first consultancy; her first client was BSkyB where she led the team responsible for launching all broadcasters' interactive services on the Sky platform.

In 2012 – for her work on UK repacking - Jules was a Women of the Year Finalist in the Cisco everywoman in Technology Awards.

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Mike Hughes, Principal Consultant & Co-Founder

From 2005 to 2012 Mike was Broadcast Director at Digital UK for the Digital TV Switchover and 800MHz repacking programs. As Broadcast Director, he led the technical planning, co-ordination and stakeholder management for the re-engineering of the entire UK television transmission network. Mike continues to consult to Digital UK through Transmit.

From 1997 to May 2013, Mike was General Manager of Digital 3and4, a multiplex license holder and a joint venture between ITV and Channel 4. He played a key role in the launch of UK's terrestrial platform Freeview (and its predecessor OnDigital), for many years he chaired the Board responsible for the technical strategy and operations of this platform.

He started his career in industry relations working for the Independent Television Companies Association in the UK and then the Australian Broadcasting Commission in Sydney. He returned to the UK to Anglia Television (part of ITV) rising to Deputy CEO. In 1995, Mike formed his first broadcast consultancy; his first major client was Channel 5 where he acted as Project Co-ordination Director for launch. He is currently a Non-Executive Director for Mustard TV, the local TV license holder in the UK.

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Mark Evans, Lead Technical Consultant

From 2005 to mid- 2013, Mark was the lead Technical Consultant at Digital UK for the Digital TV Switchover and 800MHz repacking programs. Mark is a transmission, spectrum management and TV reception expert. Mark continues to consult to Digital UK and UK wireless operators.

Mark played a key role in the development and implementation of DTT from 1997, including the negotiation of the transmission contract, and subsequently was a key member of the Freeview launch team in 2002.

Mark has worked in broadcasting for 28 years and provided industry level technical leadership in digital broadcasting since the very beginning. Mark started his career in the BBC's engineering division, project managing the procurement and installation of Long, Medium and Short Wave transmitters and antenna systems in the UK and overseas. He subsequently installed the world's first digital radio network, starting with the research pilot in 1993 followed by the operational network in 1995.

Mark remained with the BBC when BBC Transmission was privatized, establishing and leading the team responsible for managing all the contracts for delivering the BBC's services, both radio and television, over terrestrial, satellite and cable, rising to Head of Technology for Distribution with responsibility for all of the delivery of the BBC's services from transmission to reception.

Mark's current areas of particular interest are the potential impact of 4G roll-out, White Space and Dynamic Spectrum Access initiatives on DTT reception.

Pete Ansell, Consultant

Pete has worked in the broadcasting industry throughout his professional life. An engineer, he spent eighteen years with the Independent Broadcasting Authority (at the time the UK's regulator). Upon privatization of the engineering division he then joined NTL where he remained for ten years. During that time, Pete designed, built and installed the initial satellite pay TV system for United Artists Programming whose services subsequently became part of the original Sky DTH services line-up on Astra.

He also led the NTL technical team dealing with encryption that supported the "world first" terrestrial pay-TV platform – OnRequest in 2002. He subsequently achieved the role of Chief Engineer with technical responsibility for delivering system integration for one of the UK commercial multiplexes. Pete left NTL in 2001 to join SDN, a UK DTT commercial multiplex now owned by ITV.

As CTO at SDN, he was responsible for the long-term technical and strategic development of the multiplex. This involved numerous aspects of broadcast technologies relating to a system employing multiple day-part service scheduling including free to air, obfuscated and encrypted services. Further, he has the abilities to bridge the technical and commercial disciplines encountered within the industry.

As a broadcaster, representing the many broadcasters on the SDN multiplex, Pete played a significant role in UK Digital Switchover being involved in cross-business debates and decision-making. As such, he was a signatory to all broadcast processes and milestones. His experience covers a wide range of broadcast-related technologies including but not limited to aspects of terrestrial and satellite television transmission, digital television techniques including compression and platform/service management and navigation.